Herbicide Field Handbook

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SECTION A
Herbicide Prescription

PRESCRIBING A HERBICIDE FOR FOREST VEGETATION MANAGEMENT TREATMENTS: CHECKLIST

1. Site Survey/Assessment ☐
   - (a) Establish the nature of vegetation problem on the site
     - • state the size (height, diameter), abundance, distribution, and vigour of the target vegetation ☐
     - • evaluate the current and expected impact of target vegetation on reforestation ☐
     - • prepare a list of target vegetation ☐
     - • list crop trees (where applicable) ☐
   - (b) Evaluation of the Site Characteristics
     - • soils ☐
     - • sensitivity: closeness to human habitation, water resources etc. ☐
     - • importance to fisheries, wildlife and range resources ☐
2. State the Treatment Objective(s) ☐
3. Selection of the Herbicide Option: Based on Decision Making Profile ☐
4. Knowledge of the Registered and Available Herbicides
   - (a) General Properties ☐
   - (b) Methods and Techniques of Application ☐
   - (c) Efficacy and Impact on the Environment ☐
   - (d) Application Season for the Intended Objectives ☐
5. Evaluation of the Target Vegetation Species/Herbicide Treatments
   - (a) Use Already Prepared Herbicide/Target Vegetation Evaluation Table or Chart, if Available ☐
   - (b) Prepare Target Vegetation/Treatment Evaluation Worksheet (see the appropriate section of this handbook)
     - • list (rank) target vegetation species with candidate herbicide treatments (including rates and timing) ☐
     - • state expected target control of each candidate herbicide treatment ☐
     - • state expected crop damage by each candidate treatment ☐
6. Selection of the Best Herbicide Treatment that meets Treatment Objectives:
   - (a) Efficacy: degree of Control Desired to Achieve Treatment Objective ☐
   - (b) Injury to Crop Trees ☐
   - (c) Impact on Environment e.g.
     - • potable water supply ☐
     - • fish and wildlife and their habitats, and range resources ☐
   - (d) Suitability of the Application Method ☐
   - (e) Chemical Handling ☐
   - (f) Impact on Workers ☐
   - (g) Impact on Bystanders ☐
   - (h) Treatment Cost ☐
7. Treatment Implementation and Monitoring ☐
8. Treatment Effectiveness Evaluation ☐
9. Prescription Examination and Evaluation: Achievement of Reforestation/Silvicultural Objectives ☐

DECISION MAKING PROFILE FOR VEGETATION MANAGEMENT OPTIONS

Administration		
Region	District	Opening No.
Substitute	Own Use	

STEP 1 AREA IDENTIFICATION

WHERE is the proposed treatment site?
Fill in the ecological classification in the spaces provided below.

LOCATION	BGC ZONE	SUB ZONE	VARIANT	ECOSYSTEM

ASSOCIATION	TYPE/PHASE	GRID LOCATION	MOIST./NUTR.

STEP 2

WHY is treatment needed? Circle the appropriate response.

2.1 to prepare a site for "naturals" and planting	2.2 to remove competing species and/or enhance growth	2.3 to manage a "right of way"	[redacted]

STEP 3 TREATMENT OPTIONS

STOP

HOW? What method is used to execute treatment? Check 3 of the STEP 3 categories directly under the chosen STEP 2 treatment. These are your 3 option choices. You may check any of the boxes provided under the chosen STEP 2 treatment, in any combination. For example, under 2.1 you may check a Burn, a Chemical Aerial Spray and a Mechanical category OR you may check all three boxes beside a Mechanical category, indicating that you are choosing to evaluate 3 Mechanical options. Specify where indicated (i.e. V-plow, disc trencher, etc.)

STEP 3 TREATMENT OPTIONS (cont.)

To prepare a site for "naturals" and planting	To remove competing species and/or enhance growth	To manage a "right of way"
1 BIOLOGICAL, Specify _____	12 BIOLOGICAL, Specify _____	23 BIOLOGICAL, Specify _____
2 BURN	13 BURN	24 BURN
3 CHEMICAL AERIAL SPRAY	14 CHEMICAL AERIAL SPRAY	25 CHEMICAL AERIAL SPRAY
4 CHEMICAL GROUND SPRAY	15 CHEMICAL GROUND SPRAY	26 CHEMICAL GROUND SPRAY
5 CHEMICAL INJECTION	16 CHEMICAL INJECTION	27 CHEMICAL INJECTION
6 CHEMICAL/BURN	17 CHEMICAL/BURN	28 CHEMICAL/BURN
7 CHEMICAL/CHEMICAL	18 CHEMICAL/CHEMICAL	29 CHEMICAL/CHEMICAL
8 MECHANICAL Specify _____	19 MECHANICAL Specify _____	30 MECHANICAL Specify _____
9 MECHANICAL/BURN	20 MECHANICAL/BURN	31 MECHANICAL/BURN
10 PHYSICAL, Specify _____	21 PHYSICAL, Specify _____	32 PHYSICAL, Specify _____
11 OTHER? Specify _____	22 OTHER? Specify _____	33 OTHER? Specify _____

STEP 4 CONTINGENCY RATING

Write in each of the chosen 3 options from STEP 3 in the spaces provided below. Check the appropriate rank for each criterion under each of the 3 chosen options. Refer to the procedure manual if necessary. The ranks are:

☐ (far left) = ZERO ☐ = LOW ☐ = MODERATE

☐ = MOD/HIGH ■ =VERY HIGH.

Then enter treatment area for each option.

	OPTION 1 (area = _____ ha.)	OPTION 2 (area = _____ ha.)	OPTION 3 (area = _____ ha.)
4.1	Rank differences in cost of treatment. Refer to Procedure Manual		
4.2	Rank risk of treatment not working in 2 years or less (i.e. ineffectiveness)		
4.3	Rank costs of re-treatment if risk in 4.2 is Mod. to High. Refer to Manual		
4.4	Rank health risk to humans (not operators)		
4.5	Rank health risk to operators		
4.6	Rank foreseeable interest group and/or public involvement		
4.7	Rank risk of effect on potable water supply		
4.8	Rank risk to wildlife		
4.9	Rank risk to fish		
4.10	Rank effect on soil		
4.11	Rank effect on environmental aesthetics		
4.12	Rank difficulty of terrain for treatment		
4.13	Rank difficulty for operator to perform		
4.14	Rank site access difficulty for a labour crew or machinery		
4.15	Rank risk of treatment injuring crop		

STEP 4 CONTINGENCY RATING (cont.)

	OPTION 1	OPTION 2	OPTION 3
4.16 Rank risk of reducing required grazing forage			
4.17 Other? Specify:			
4.18 Other? Specify:			
4.19 Other? Specify:			
4.20 Other? Specify:			

STEP 5 EVALUATION

Count up the number of times each shade occurs in each of the 3 options. Enter the numbers below on the line, beside the box of the same shade for each of the 3 options, e.g., in STEP 4 for Option 1, you checked 6 light, 6 [ ] and 4 [ ] shades. In STEP 5, under Option 1 you write in the number 6 next to the white box, 6 next to the light shaded box [ ] and 4 next to the [ ] box. The remaining boxes remain blank.

Option 1	Option 2	Option 3
[ ] ___	[ ] ___	[ ] ___
[ ] ___	[ ] ___	[ ] ___
[ ] ___	[ ] ___	[ ] ___
[ ] ___	[ ] ___	[ ] ___
[ ] ___	[ ] ___	[ ] ___

STEP 6 SELECTION

Look to the evaluation in STEP5.

ANY [ ] = STOP AND RECONSIDER

Compare the number of a shade for one option with the number of the same shade for the remaining options (i.e., a burn option may have 2 of the darkest shade compared with a manual option with 4 of the darkest shade. Recognize that, in general, the more pale shades you observe on your evaluation of an option, the better the option.

OPTION ____, _____ is, in my judgement, the best choice, given the site and treatments available.

STEP 7 MANAGEMENT EMPHASIS

In some cases, a particular method may be selected in STEP6, notwithstanding certain potentially higher risk factors, as identified in STEP 4.

In the spaces provided below, state the Potential Problem and Reference Number from STEP 4 and present Recommended Measures to Reduce the Risk level.

Reference Number	Potential Problem	Recommended Measures to Reduce the Risk Level

STEP 8 APPROVAL

8.1 Completed by:

Signature	Position	Date

8.2 District Review:

☐ Approved ☐ Approved as revised

☐ Approved with referral ☐ Rejected

It is recommended that this Decision-Making Profile be forwarded for review by the Region.

☐ YES ☐ NO

If YES for STEP 8.3:
State reason for evaluation by the Region.

Signature	Position	Date

8.3 Regional Review:
This Decision-Making Profile has been reviewed by the Region and the treatment recommendations are:

☐ Approved ☐ Approved as revised ☐ Rejected

Regional Comments:

Signature	Position	Date

PROPERTIES AND USES OF REGISTERED FORESTRY HERBICIDES IN CANADA

Herbicide (Common Name)	Examples of Formulation (Manufacturer) PCP No.	Guaranteed % (a.i., a.e.)	Type* of Registration	Target Vegetation Group	Uptake Route	Application Method**
Amitrol	Amitrol-T® (Allied Chemical) 16548	20	W	Annual and perennial grasses broadleaves	Foliage, roots	G
Amitrol + Simazine	Amizine Industrial WP® (Union Carbide) 8655	15+45[a]	W	Annual and perennial grasses, broadleaves	Foliage, roots	G
Asulam	Asulox F® (May and Baker) 11341	40	W	Bracken fern	Foliage	G
Glyphosate	Vision® (Monsanto) 13644	35.6	F and W	Annual and perennial weeds, Hardwood trees	Foliage, cut surfaces	G, A S, I
Hexazinone	Velpar L® (Dupont) 18197	24	W	Annual, biennial and perennial weeds and grasses; hardwood trees	Foliage, Roots	G, ST
	Pronone 5G® (United Agri Products) 21389	5	W	Grasses and herbaceous species woody deciduous plants	Roots	G
	Pronone 10G® (United Agri Products) 21390	10	W	Grasses and herbaceous species woody deciduous plants	Roots	G
MSMA	Glowon® (United Agri Products) 10892	44.9[b]	F	Conifers	Cut surfaces	I

Simazine	Simadex 80W® (FBC) 13561	80	W	Grasses and broadleaves germinating plants	Roots	G
2,4-D amine	Forestamine® (United Agri Products) 16995	47	F and W	Alder and willow	Cut surface	G, I
	Formula 40® (Dow Elanco) 16994	47	F and W	Alder and willow	Cut surface, foliage	G, I, A
	Guardsman Silvamine 500® (Van Waters and Rogers) 19385	48	F and W	Alder and willow	Cut surface	G, I
2,4-D ester	Esteron 600® (Dow Elanco) 15981	60	F and W	Shrubs, broadleaved forbs hardwood trees	Stem, foliage, cut surface	G, A S, I, B
	For-Ester (United Agri Products) 16675	47	F	Shrubs, broadleaved forbs, hardwood trees	Stem, foliage cut surface	G, A S, I, B
2,4-D ester + 2,4-DP ester	Weedone CB® (May and Baker) 19780	8 + 8	F and W	Woody plants	Stem, cut surface	G, S I, B
Triclopyr[c]	Release® (Dow Elanco)	44.3	F and W	Shrubs and broadleaved forbs, hardwood trees	Stem, foliage cut surface	G, A S, I, B

Notes:
[a] 15% amitrol and 45% simazine
[b] Equivalent to 32% Arsenic
[c] Currently not registered for forestry in Canada; Garlon 4® is Release® in Canada

***Type of Registration:**
F = Forest Management Registration (> 500 ha of a treatment site)
W = Woodland Registration (< 500 ha of a treatment site)

****Application Method:**
A = Aerial
B = Basal
I = Stem Injection/Frill
S = Stump
G = Ground Broadcast
ST = Spot

Source: Manufacturers' labels

Method	Herbicide	Technique
Aerial Broadcast Spraying (Helicopter, Fixed-Wing Aircraft)	Vision (glyphosate)	3-6 L/ha in 30-100 L/ha of clean water. Higher volume for dense/multi-level vegetation. Average droplet size (or VMD) 250-500 micron diameter.
	Esteron 600 For-Ester (2, 4-D ester)	5.5-8.5 L/ha Esteron 600 or 6.6-10.2 L/ha For-Ester in 30-100 L/ha spray mixture. Carriers: water, oil, oil-water mixture; 10% oil solution best. Avoid spraying after polonged dry period.
Bark Treatment	Esteron 600 For-Ester (2, 4-D Ester) Weedone CB (2, 4-DP)	Use 3% herbicide oil solution of 2, 4-D ester or full strength Weedone CB. Treat stems to a height of 50 cm from the ground.
Grid Spot Application	Velpar L (hexazinone)	Apply 9-18 L full strength product per hectare using a spot gun. Direct application to soil. Lower rates for soils low in organic matter and clay. Spot should be placed 1 m from stem of desirable trees.
Ground Broadcast Spraying: Backpack	Forestamine (2, 4-D amine) Vision (glyphosate)	6-8 L Forestamine in 1000 L of water. Thorough foliage coverage: 3-6 L/ha of Vision in 100-300 L/ha of clean water. Vegetation not taller than 2.5 m.
	Velpar L (hexazinone)	9-18 L/ha. Use at least 5 L of water for each litre of Velpar L.
Ground Broadcast Spraying: Granular Herbicide Applicators (e.g. Granulair Applicator)	Pronone 10G Pronone 5G (hexazinone)	For site preparation: Apply 20 to 40 kg of Pronone 10G (or 40 to 80 kg of Pronone 5G) per ha, uniformly on the soil surface. Lower rate: medium textured soils. Higher rate: fine textured soils high in organic matter and for hard-to-kill species. Do not use on gravelly, rocky, sandy, coarse textured or frozen soils, waterlogged sites or sites with water table close to the surface.

Ground Broadcast Spraying: Vehicle Mounted Sprayers (Power-operated Hand Gun)	For-Ester Esteron 600 (2, 4-D Ester)	5-8 L/ha (or 6-9 L For-Ester) in 1000 L of water. Vegetation up to 2.5 m tall. Well developed foliage. Avoid spraying after prolonged dry period. Good coverage; spray to runoff.
Hack-and-Squirt or Frill	Formula 40F Forestamine Silvamine 500 (2, 4-D amine)	For trees > 15 cm dbh make complete frill. Trees < 15 cm dbh make one notch for every 3 cm dbh. All notches should angle downwards to hold herbicide solution. Add 1 mL undiluted product or up to 2:1 dilution per notch. For frill, add sufficient herbicide solution but without runoff. Use full strength for trees > 15 cm dbh.
	Vision (glyphosate)	Apply 1 mL of undiluted (or up to 50% dilution of 1 mL) product for every 10 cm dbh. Tree > 20 cm dbh may not be controlled.
	Esteron 600 (2, 4-D ester)	Treat freshly cut frill with 3% oil solution (30 L/1000 L) of 2, 4-D Esteron 600.
	Glowon (MSMA)	For conifers < 15 cm with full crown, cut a frill for every 2.5 cm dbh and apply 1 mL Glowon. Those with 1/2 or less complete crown apply 1 mL for every 5 cm dbh cut. Overlapping frill required for full crown large trees.
Stump Treatment	Formula 40F Forestamine Silvamine 500 (2, 4-D amine) Vision (glyphosate)	Cut stem close to ground (< 50 cm from ground) with brush saw or chainsaw. Apply 2, 4-D or glyphosate immediately to freshly cut stumps and stubs using brush or sprayer with full strength or up to 2:1 water:herbicide dilution. Ensure coverage of cambial layer.
	Esteron 600 (2, 4-D ester)	Mix 30 L Esteron 600 in 1000 L diesel oil, fuel oil or kerosene. Apply to the freshly cut surface. Ensure coverage of cambial layer.
	Weedone CB (2, 4-DP)	Apply full strength Weedone CB to cut stump. Immediate treatment not required.

Sources: Herbicide manufacturers' labels; Table adapted from FRDA publication, Regenerating British Columbia's Forests.

SUGGESTED SPRAY NOZZLES AND TIPS

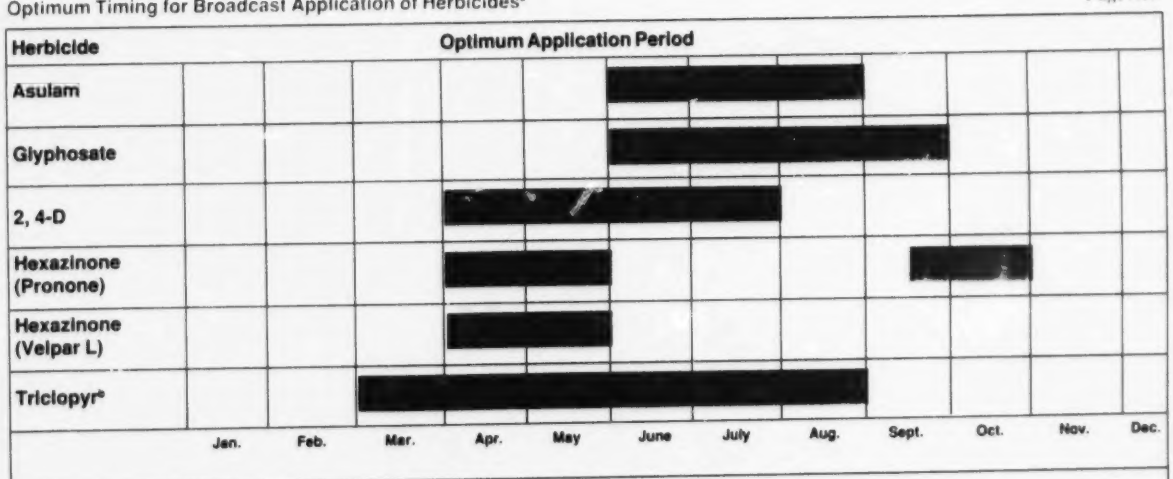
Spray Application	Nozzle Tip	Examples
Aerial Broadcast	Hollow Cone (Disc - Core)	Delavan Raindrop Regular Disc-core D8-46
Ground Broadcast	Flat Fan	Teejet® 650067
	Flooding Flat Fan	D.75SS
	Straight (Solid) Stream	1505-45
	Cluster or Boomless (Broadcast)	Boomjet 5880
Band/Strip	Even Flat Fan	Teejet® 9503E
Basal (Bark):		
Spraying to wet-	Even Flat Fan	Teejet® 8003E
Thinline Spraying	Straight (Solid) Stream	TP 0001
Spot: Grid pattern or individual stem	Straight (Solid) stream	TP 0001, TP 0002 TP 0003
Tree-centred spots (for herbaceous vegetation)	Hollow cone	DC 3-25
	Solid Cone	TG -1

Sources:

Cantrell, R.L. 1985. Guide to Silviculture Use in the Southern United States. Auburn University, Alabama.

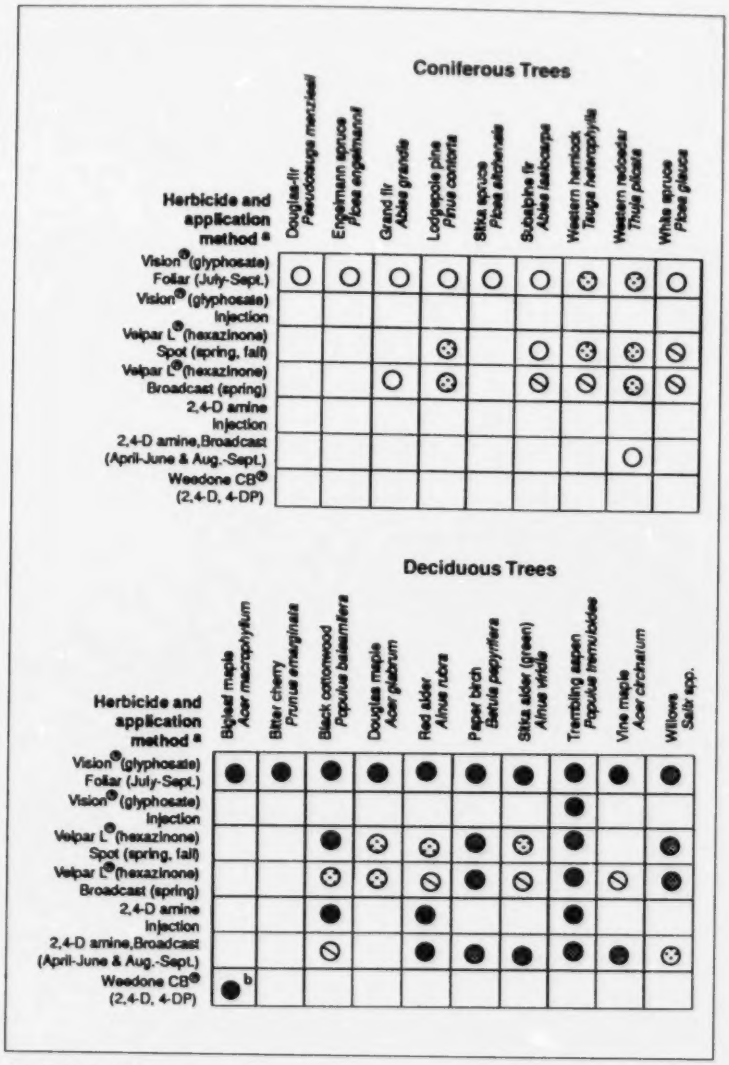
Newton, M. and F.B. Knight 1981. Handbook of Weed and Insect Control Chemicals for Forest Resource Managers. Timber Press. Beaverton, Oregon.

Optimum Timing for Broadcast Application of Herbicides[a]



[a] Broadcast treatments except hexazinone, which refers to both broadcast and spot treatment.

[b] Triclopyr is currently not registered for forestry use in Canada.

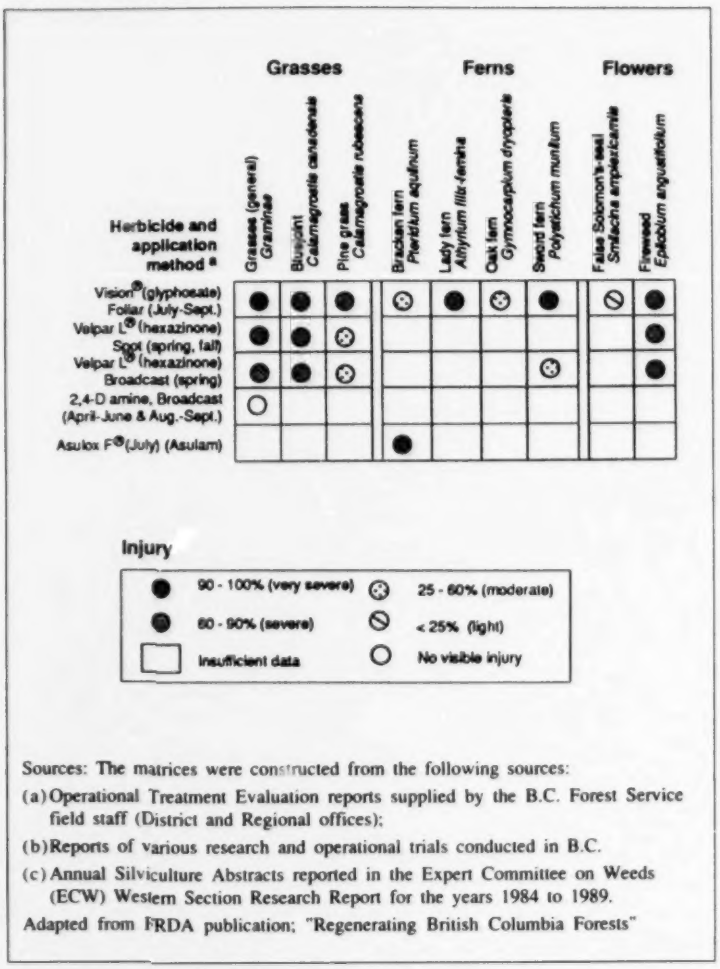

Coniferous Trees
Herbicide and application method a
Douglas-fir Pseudotsuga menziesii
Engelmann spruce Picea engelmannii
Grand fir Abies grandis
Lodgepole pine Pinus contorta
Sitka spruce Picea sitchensis
Subalpine fir Abies lasiocarpa
Western hemlock Tsuga heterophylla
Western redcedar Thuja plicata
White spruce Picea glauca
Vision® (glyphosate) Foliar (July-Sept.)
Vision® (glyphosate) Injection
Velpar L® (hexazinone) Spot (spring, fall)
Velpar L® (hexazinone) Broadcast (spring)
2,4-D amine Injection
2,4-D amine, Broadcast (April-June & Aug.-Sept.)
Weedone CB® (2,4-D, 4-DP)
Deciduous Trees
Herbicide and application method a
Bigleaf maple Acer macrophyllum
Bitter cherry Prunus emarginata
Black cottonwood Populus balsamifera
Douglas maple Acer glabrum
Red alder Alnus rubra
Paper birch Betula papyrifera
Sitka alder (green) Alnus viridis
Trembling aspen Populus tremuloides
Vine maple Acer circinatum
Willows Salix spp.
Vision® (glyphosate) Foliar (July-Sept.)
Vision® (glyphosate) Injection
Velpar L® (hexazinone) Spot (spring, fall)
Velpar L® (hexazinone) Broadcast (spring)
2,4-D amine Injection
2,4-D amine, Broadcast (April-June & Aug.-Sept.)
Weedone CB® (2,4-D, 4-DP)
b

Shrubs

Herbicide and application method [a]	Devil's club *Oplopanax horridus*	Elderberry *Sambucus* spp.	False azalea *Menziesia ferruginea*	Falsebox *Pachistima myrsinites*	Hazelnut *Corylus cornuta*	Highbush-cranberry *Viburnum trilobum*	Honeysuckle *Lonicera utahensis*	Huckleberry *Vaccinium* spp.	Mountain ash *Sorbus sitchensis*	Oval-leaved blueberry *Vaccinium ovalifolium*	Raspberry *Rubus idaeus*
Vision® (glyphosate) Foliar (July-Sept.)	⊘	●	●	⊘	⊘	⊘	●	●	●	●	●
Velpar L® (hexazinone) Spot (spring, fall)					⊘	⊘			⊘		⊘
Velpar L® (hexazinone) Broadcast (spring)					⊘	⊘			⊘		⊘
2,4-D amine, Broadcast (April-June & Aug.-Sept.)							●				
Asulox F® (Asulam)											

Shrubs (cont.)

Herbicide and application method [a]	Red-osier dogwood *Cornus sericea*	Rhododendron *Rhododendron albiflorum*	Roses *Rosa* spp.	Salal *Gaultheria shallon*	Salmonberry *Rubus spectabilis*	Saskatoon berry *Amelanchier* spp.	Snowberry *Symphoricarpos albus*	Stink currant *Ribes bracteosum*	Thimbleberry *Rubus parviflorus*	Twinberry *Lonicera involucrata*	Twinflower *Linnaea borealis*
Vision® (glyphosate) Foliar (July-Sept.)	⊘	●	●	○	⊘	●	●	●	●	●	◎
Velpar L® (hexazinone) Spot (spring, fall)	⊘		●	○		●	●	⊘	⊘	◎	
Velpar L® (hexazinone) Broadcast (spring)	⊘		●	○		⊘		⊘	⊘	◎	
2,4-D amine, Broadcast (April-June & Aug.-Sept.)											
Asulox F® (Asulam)											



Sources: The matrices were constructed from the following sources:

(a) Operational Treatment Evaluation reports supplied by the B.C. Forest Service field staff (District and Regional offices);

(b) Reports of various research and operational trials conducted in B.C.

(c) Annual Silviculture Abstracts reported in the Expert Committee on Weeds (ECW) Western Section Research Report for the years 1984 to 1989.

Adapted from FRDA publication; "Regenerating British Columbia Forests"

Target Vegetation Herbicide Evaluation Worksheet

Target Vegetation (Rank)	Percent Cover	Herbicide Treatment				Comments (e.g. Effect on Crop)

SECTION B
Herbicide Project Planning

Steps:

1. Site Assessment and Prescription including current survey data ☐
2. Public and Legal Activities
   - (a) Pesticide Use Permit Application ☐
   - (b) Pre-permit Approval Advertising ☐
   - (c) Public Meeting(s) or Discussion with affected groups or individuals ☐
   - (d) Permit Approval ☐
   - (e) Permit Advertisements ☐
   - (f) Permit Appeal Notification ☐
   - (g) Permit Appeal Hearing ☐
   - (h) Permit Appeal Results ☐
3. Project Tendering ☐
4. Project Viewing and Contracting ☐
5. Equipment and Supplies Needed ☐
6. Personnel Needs and Training ☐
7. Pre-operations Orientation
   - (a) Pre-work Conference ☐
   - (b) Briefing of Ministry Personnel ☐
   - (c) Tentative Treatment (Flight) Plan
     - (i) spray schedule ☐
     - (ii) mixing schedule ☐
     - (iii) check for helispot(s) condition ☐
     - (iv) check for water sources ☐
     - (v) check for roads ☐
     - (vi) check for alternatives to (iii-v) ☐
     - (vii) emergency plan ☐
   - (d) Notifications
     - (i) Pesticide Control Branch and Region, the name and licence number of Contractor ☐
     - (ii) Other notifications as required by the permit
8. Pre-treatment checks
   - (a) Supervision
     - (i) Supervisor/workers ratio ☐
     - (ii) Applicator certificates ☐
   - (b) Pilot
     - (i) name and experience ☐
     - (ii) appropriate licences and certificates ☐
     - (iii) pilot weight for maximum load calculation ☐
     - (iv) check if pilot is the same used for pre-contract viewing ☐
   - (c) Equipment Checks
     - (i) aircraft
       - aircraft type ☐
       - required spray system specification for contract ☐
       - appropriate boom length ☐
       - proper nozzle: type, size, placement and orientation ☐
       - inspection for leaks ☐
       - calibration: application rate, droplet size, spray pattern ☐
       - air-ground radio compatibility ☐
     - (ii) batch truck check
       - chemical left over in tank from previous job ☐
       - leak in hoses, tanks and pump ☐
       - tank: size, compartmentation and material ☐
       - screens and line filter ☐
       - functioning agitation system ☐
       - mechanism to prevent back siphoning ☐
       - secure and safe locking device ☐
       - vehicle safety regarding fire regulations ☐

(iii)Backpack Sprayers
- inspection for tank, hose or nozzle leaks ☐
- appropriate nozzle ☐
- sprayer flushing before use ☐

(iv) Truck-Mounted Sprayer
- presence of agitator, if necessary ☐
- inspection for leaks ☐
- tank flushing before use ☐

(v) Hack and Squirt Equipment
- applicator leaks (bottles, etc.) ☐
- capability of delivering required chemical ☐

9. Day before Treatment Checks ☐
(a) Equipment Needs ☐
(b) Weather Forecast ☐
(c) Review of Treatment Area with Applicator (Contractor) ☐
(d) Discussion of Spray Operation with Key Personnel ☐
(e) Designation of mixing and disposal sites ☐
(f) Spray Mixture Calculation Checks ☐
(g) Chemical Security Plan ☐
10. Daily Spray Operations ☐
(a) Prior to Treatment Checks
(i) required equipment and materials including minimum personal safety equipment and clothing ☐
(ii) First Aid and Spill Kit on site ☐
(iii) contingency plan ☐
(iv) posting of information signs ☐
(v) monitoring: equipment and plan (placement of spray monitoring cards and/or other samplers) ☐
(vi) boundary and swath markers ☐
(vii) contractor's (or pilot's) knowledge of treatment area, "pesticide free zones", buffer areas, water bodies and hazards ☐
(viii) mixing and loading: applicator's (mixer's) awareness of required rates and carrier volume ☐
(ix) radio communications (especially ground-to-air) ☐
(x) equipment calibration ☐
(xi) weather reading ☐
(b) During Spraying Checks ☐
(i) weather reading (e.g. F.S. 705) ☐
(ii) recording of operational activity (e.g. F.S. 705) ☐
(iii) application rate ☐
(iv) secure and safe work conditions and procedures ☐
(v) swath pattern and spray samplers ☐
(c) End of Daily Operation Check ☐
(i) collection and viewing of monitors: spray deposit cards and/or other samplers ☐
(ii) rinsing and empty container removal ☐
(iii) mixing and loading site clean-up ☐
(iv) posting of sprayed areas: information signs ☐

- (v) aircraft and batch tank security check ☐
- (vi) closure of valves or valve compartment of batch truck ☐
- (vii) notification of permit infringements to MoF district and regional offices and Pesticide Control Branch ☐
- (viii) notification of regional office of problems relating to contractor's performances (enter on e.g. F.S. 758 form) ☐
- (ix) daily de-briefing ☐

11. Project Completion (Post-operations) Checks
    - (a) Final Clean-up: Mixing / Loading Site(s) and Camp Site ☐
    - (b) Disposal of Excess Mixture ☐
    - (c) Clean-up of Pumps, Hoses, Trucks and /or Aircraft and Spray Equipment ☐
    - (d) Disposal of Waste and Empty Containers ☐
    - (e) Delivery of "Returnable" Containers to Pick-up Depot ☐
    - (f) Removal of Appropriate Signs, and Markers ☐
    - (g) Paperwork completion, including F.S. 758 ☐
    - (h) Inventory of Chemicals ☐
    - (j) Replacement of Supplies ☐
    - (j) Equipment Repair, Maintenance and Replacement ☐
    - (k) Project Completion Debriefing ☐
12. Project Evaluation (F.S. 706) ☐

Additional Items and Notes:

APPLICATION EQUIPMENT AND SUPPLIES CHECKLIST

1. Herbicides, Adjuvants, Dyes Carrier ☐
2. Project Monitoring Equipment and Material
   - (a) Dye kit (plastic gloves, funnel, mixing containers) ☐
   - (b) Spray deposit cards and/or other monitoring supplies ☐
   - (c) Measuring Tape (Broadcast Spraying) ☐
   - (d) Camera and Film ☐
   - (e) Field Notebooks and Pencils ☐
3. Radios (and radio batteries) ☐
4. First Aid Kits ☐
5. Spill Kits including Contingency Plan ☐
6. Emergency Contact List ☐
7. Protective Gear: e.g. Coveralls, Gloves, Goggles, Boots, etc. ☐
8. Wash kit (water containers, basin, soap) ☐
9. Water Sampling Equipment and Material (where applicable) ☐
10. Weather Instruments:
    - (a) Psychrometer ☐
    - (b) Humidity Chart (where applicable) ☐
    - (c) Wind Gauges ☐
    - (d) Thermometer ☐
11. Calibration Equipment and Supplies (Broadcast Spraying)
    - (a) Deposit cards ☐
    - (b) Adding machine tape ☐
    - (c) Stop watch ☐
    - (d) Calculator ☐
    - (e) 50 m tape ☐
12. Documents:
    - (a) Pesticide Use Permit Application(s) ☐
    - (b) Pesticide Use Permit ☐
    - (c) Licences and Certificates ☐
    - (d) Contract ☐
13. Photos and Maps ☐
14. Public Notification Signs ☐
15. Information on the Pesticide(s)
    - (a) Label ☐
    - (b) Material Safety Data ☐
16. Forms
    - (a) Herbicide Operation Records ☐
    - (b) Daily Flight or Treatment Log (kept by Service Licensee) ☐
    - (c) Application Table(s) or Pesticide Field Data Book ☐

Additional Items and Notes:

- 1. Contract/Project No. ☐
- 2. Pesticide Use No. ☐
- 3. Location, Date, Time of Pre-work Conference ☐
- 4. Ministry Contract Officer's Name and Phone Number ☐
- 5. Contractor's Information:
  - a) Name, Address and Phone No. ☐
  - b) Pesticide Service Licence No. ☐
  - c) Applicators' Certificates ☐
  - d) Workers' Compensation Board Number ☐
- 6. Project Administration
  - a) Project Commencement Date ☐
  - b) Project Completion Date ☐
  - c) Order of Work ☐
  - d) Expected Production Rate ☐
  - e) Notice to Commence Work ☐
  - f) Required Supervision ☐
  - g) Signed Work Progress Plan ☐
- 7. General Review of Contract Schedules ☐
- 8. Review of Pesticide Use Permit Conditions ☐
- 9. Safety Requirements
  - a) Worker's Safety Equipment and Clothing ☐
  - b) First Aid Kit ☐
  - c) Spill Kit ☐
  - d) Wash-up Facilities ☐
  - e) Fire Prevention Regulations ☐
  - f) Contingency Plans ☐
  - g) Camp Standards ☐
- 10. Emergency Communication ☐
- 11. Herbicide Handling
  - a) Pick-up Location and Delivery to Site ☐
  - b) On-site Storage ☐
- 12. Herbicide Mixing
  - a) Location ☐
  - b) Water Source ☐
  - c) Mixing Procedure ☐
- 13. Herbicide Application
  - a) Pesticide Free Zones ☐
  - b) Buffer/Boundary Markings ☐
  - c) Review of Problem Areas ☐
  - d) Application Equipment ☐
  - e) Application Method/ Technique ☐
  - f) Equipment Calibration ☐
  - g) Weather Conditions for Application ☐
- 14. Herbicide Operation Record Keeping ☐
- 15. Site Clean-up and Empty Container Handling
  - a) Site/Camp Clean-up ☐
  - b) Disposal of Left-over Spray Mixture ☐
  - c) Disposal of Empty Containers ☐
  - d) Delivery of "Returnable" Empty Containers ☐
- 16. Project Monitoring and Inspection
  - a) Method(s) ☐
  - b) Required Work Standards ☐
  - c) Stop Work Order Conditions and Contract Cancellation ☐
  - d) Rework Order ☐
- 17. Payment Method (including Policy and Hold-back Required) ☐

SECTION C

Equipment Calibration and Herbicide Application Information

FACTORS AFFECTING CALIBRATION

Vegetation height/density

Low vegetation and/or scattered clumps will require less solution per hectare than taller dense vegetation with greater leaf surface.

Nozzle/pressure

Solution delivery from the sprayer varies with the nozzles used and/or pressure. For most herbicide projects the recommended pressure is 100 to 140 kPa (15 - 20 psi) for backpack sprayers and 175 to 240 kPa (25 - 35 psi) for power operated sprayers.

Ground Conditions

For backpack projects the ground conditions (slash, slope, etc.) will affect the workers walking speed, which directly affects the delivery rate per hectare. If conditions vary substantially within the site or from site to site, the equipment should be recalibrated.

The most accurate method of calibration is to actually spray an area of known size and measure the amount of solution used over this known area.

CALIBRATION STEPS:

1. Partially fill the sprayer with clean water and dye.
2. Ensure there is no leakage from equipment.
3. Test spray sample cards to check spray droplet pattern. If necessary adjust or change nozzles and pressure to achieve desired spray droplet pattern.
4. Measure the effective swath width (e.g. 10 m).
5. Fill the spray tank with a known quantity of water.
6. Spray a small homogeneous area (e.g. 0.25 ha or 10m X 250 m) at the desired pressure and speed (to be used in the field).
7. Measure the volume of water remaining in the spray tank.
8. Calculate the litres used and determine spray output in litres per hectare (litres used divided by hectares of test).

Generally, the equipment is adjusted to deliver the solution within a certain range (e.g. 75 - 125 L/ha). To achieve the desired rate the worker can change the nozzle(s) or speed of the equipment. **It is not advisable to increase the pressure to increase the delivery rate, as this will result in fine droplets susceptible to drift.**

With backpack sprayers, it can be difficult to maintain a consistent pressure and walking speed, which is necessary for uniform application. A pressure regulator valve, which is available as an option if not already built into the sprayer, will ensure uniform delivery of solution from the sprayer. Close attention must be paid to walking speed in order to minimize variation in application rates.

AERIAL SPRAYER CALIBRATION CHECKLIST

EQUIPMENT AND SUPPLIES

- (a) Stopwatch ☐
- (b) Calculator ☐
- (c) Paper and Pencils ☐
- (d) Calibration Tables (eg. Manufacturer's Tables) ☐
- (e) 20-litre calibrated bucket ☐
- (f) Adding machine tapes ☐
- (g) Deposit Cards (e.g. Kromekote cards) or samplers ☐
- (h) Dye ☐
- (i) Gauge for measuring nozzle orifice diameter (optional) ☐
- (j) 50-metre measuring tape ☐

PROCEDURES

1. Select nozzle type and number, pump pressure, application speed and swath width ☐
2. Check functioning of the Sprayer System
   - (a) Wash out tank to remove dust or oil ☐
   - (b) Check hoses for holes and wear ☐
   - (c) Check pump to be sure it turns freely ☐
   - (d) Check strainer screen ☐
   - (e) Clean, replace or repair defective parts ☐
3. Delivery System Priming (i.e. filling the plumbing lines with liquid)
   - (a) Add about 50 litres of water into spraying tank (hopper) ☐
   - (b) Spray system until empty (as boom pressure starts to drop shut off boom) ☐
   - (c) Check for leaks or clogged nozzles ☐
   - (d) Repair leaks and nozzle problems ☐
4. Measuring Discharge Time
   - (a) Add measured amount of water (between 125 and 250 L) into tank. ☐
   - (b) Measure the time required to empty tank at the chosen operating pressure and speed. ☐
   - (c) Compare measured time with the values calculated for the chosen swath width, speed, application rate (volume/area) ☐
5. Measured Discharge time:
   - (a) Correct, refer to item 7 ☐
   - (b) Incorrect, refer to item 6 ☐
6. Discharge Time Adjustment
   - (a) If measured time is less than tabulated minimum value; repeat calibration procedure after one of the following:
     - (i) Checking and replacing worn (oversize) nozzles ☐
     - (ii) Removing or shutting off some of the nozzles (Always start from the boom end) ☐
     - (iii) Adjusting for proper boom pressure, if too high* ☐
   - (b) If measured time greater than tabulated maximum value; repeat calibration procedure after one of the following:
     - (i) Cleaning nozzles or replacing nozzles, ☐

(ii) Increasing the number of nozzles ☐

(iii) Adjusting for proper boom pressure, if too low* ☐

(In general the pressure should be left alone; only minor changes in delivery rate can be achieved by changing the pressure.)

(c) Erratic Discharge Time (after 3 trials); check for:

(i) Defective Pump System ☐

(ii) Presence of foreign material (dirt) in spray system, batch truck, calibration solution ☐

(iii) Defective or incorrectly used stop watch ☐

7. Spray System Calibration Check in the air

(a) Spray a swath. Check effective swath width, average droplet size, droplet spectrum, and droplet distribution (number per unit area)**. Adjust if necessary. ☐

(b) Measure a unit area accurately ☐

(c) Spray the whole unit (using the chosen pressure and speed), and record the spray volume used ☐

(d) Check for correct application rate (volume/area)*** ☐

Notes:

* Major change of pressure not recommended.

** At least 13 droplets/cm^2 are needed for phenoxy herbicides (Newton & Knight, 1981. Handbook of Weed and Insect Control Chemicals for Forest Resource Managers. Timber Press. Oregon.) For most herbicides no more than 20 and 40 droplets/cm^2 are required for pre-emergence and post-emergence, respectively (Ciba-Geigy, Correct Aerial Application of Pesticides).

*** Error within ±5% is preferred but up to 10% error is operationally acceptable)

Calculation of litres the system sprays per minute (L/min) when the following are known:

Speed of the sprayer (e.g. aircraft) = 70 km/h
Swath width = 15 m
Application rate = 50 L/ha

Solution

$$\text{Flow Rate} = \frac{\text{Speed (km/h) X Swath Width (m) X Application Rate (L/ha)}}{\text{600 (Conversion Factor)}}$$

$$= \frac{70 \text{ X } 15 \text{ X } 50}{600}$$

$$= 87.5$$

Calculation of litres the system sprays per hectare (L/ha) when the following are known:

Speed of the sprayer (e.g. aircraft) = 70 km/h
Swath width = 15 m
Flow rate of the system = 87.5 L/min

Solution

$$\text{Amount sprayed/area (L/ha)} = \frac{\text{Amount Sprayed per Min (L/min) X 6000}}{\text{Swath Width (m) X Speed (km/h)}}$$

$$= \frac{70 \text{ X } 15 \text{ X } 50}{15 \text{ X } 70}$$

$$= 50$$

Calculation of hectares treated per minute when the following are known:

Speed of the sprayer (e.g. aircraft) = 70 km/h
Swath width = 15 m

Solution

$$\text{Hectares/min} = \frac{\text{Swath width (m) X Speed (Km/h)}}{600}$$

$$= \frac{15 \text{ X } 70}{600}$$

$$= 1.75 \text{ ha / min}$$

Calculation of Number of Nozzles needed for spraying when the following are known:

Swath width = 18 m
Speed of the sprayer (e.g. aircraft) = 72 km/h
Operating pressure = 160 kPa
Nozzle type and size = D8 - 46

Solution

$$\text{Hectares per minute} = \frac{\text{Swath Width x Speed}}{600}$$

$$= \frac{18 \times 72}{600}$$

$$= 2.16 \text{ ha / min}$$

Litres per minute = Hectares/min x Application Rate*

* From the manufacturers data the delivery rate (minute per nozzle) of D8 - 46 nozzle at 160 kPa is 5.43 min / nozzle

$$\text{Therefore, number of nozzles} = \frac{120.96}{600}$$

$$= 22.27$$

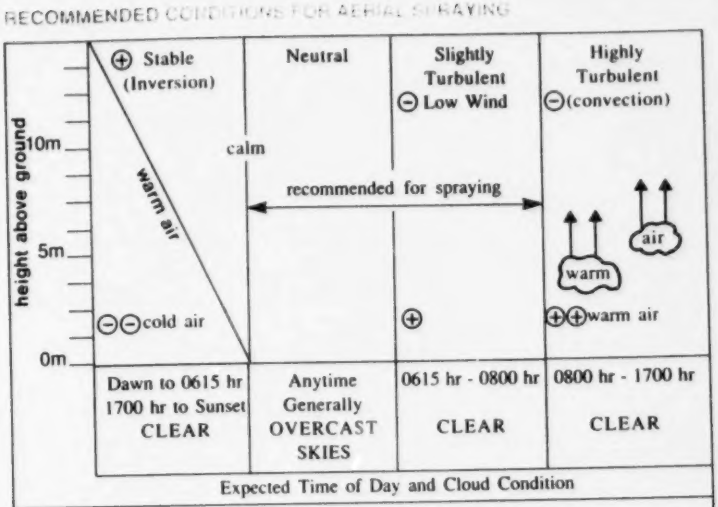
$$= 22$$

WEATHER CONDITIONS LIMITING HERBICIDE BROADCAST SPRAYING

Weather	Adverse Conditions*	
	Ground Spraying	**Aerial Spraying**
Wind	Wind velocity exceeding 8 kph	Wind velocity exceeding 8 kph or or when wind is dead calm
Temperature	Freezing temperature or temperature greater than 30° C	When temperature exceeds 21° C for application with ester formulated products (e.g. Esteron 600) When temperature exceeds 26.5° C for application with amine formulations (e.g. 2, 4-D Amine or Vision) When temperature is at or below 0° C
Relative Humidity	RH less than 30% When RH and temperature conditions create uncomfortable conditions for ground workers	RH less than 50% RH as low as 40% may be accepted when high volume and large droplets (as produced by D8 - 46) are used
Precipitation	Snow, heavy dew or ice covers brush When raining When precipitation is within 6 hours following foliar herbicide application (Check label for specific instructions)	Snow or ice covers brush When vegetation is too wet (as a a result of heavy dew or precipitation) When precipitation is predicted within 6 hours following foliar herbicide application
Atmospheric Instability and other conditions	Foggy weather and inadequate daylight for safe application	Inversion Air turbulence (e.g. thermal updrafts) so great as to seriously affect the normal application pattern Foggy weather and inadequate daylight for safe application

*When spraying should not occur

RECOMMENDED CONDITIONS FOR AERIAL SPRAYING



⊕ Warmer Air
⊖ Cooler Air

Sunrise is assumed to be 0600 and sunset at 1900. Adjust schedule to local time.

References:

Handbook on Aerial Application of Herbicides. USDA Forest Service (1983) R-5 FSH 2109.21; Correct Aerial Application of Pesticide. CIBA GEIGY Agricultural Chemical Division, Basle, Switzerland.

REDUCING HERBICIDE SPRAY DRIFT

1. Use larger and more uniform droplet sizes: droplets with 250 - 500 mm diameter are suitable for most forest herbicide applications.
2. Spray as close to the target vegetation as possible. Greater flying heights (by the aircraft) can lead to increased drift.
3. Spray under ideal weather conditions.
4. Use the appropriate application method/technique and experienced applicators.
5. Provide adequate buffers.
6. Use drift control additives

ASULAM

1. Avoid spraying if rain is expected within 4 hours, or if foliage is wet.
2. Do not spray in hot, humid weather conditions.
3. Do not spray if crop is under stress due to drought or excessive soil moisture.
4. Do not cut or disturb field after treatment.
5. Surfactant reduces effectiveness.

GLYPHOSATE

1. Rain after application of glyphosate reduces effectiveness; - a six to twelve hour rainfree period is desired.
2. Effectiveness can occasionally be erratic, and will be ineffective for no known reason.
3. Excessive mechanical disturbance to a site just before and immediately after application may reduce effectiveness.
4. Has no residual activity to control weeds that emerge after application.
5. Requires a week or more to control annuals and longer for perennials.
6. Low spray volumes are more effective than higher volumes.
7. No rapid foliage injury from very concentrated sprays.
8. Control of perennial vegetation increases with age to about the flowering stage. Late summer to early fall application effective for woody plant control.

HEXAZINONE

1. Moisture is needed to activate the herbicide. Soil should be moist at the time of application and six to thirteen millimetres of rainfall is needed within 2 weeks after application.
2. Do not use on gravelly soils or exposed subsoils or on coarse textured soils (sands to sandy loams) with less than 2% organic matter nor on fine soils (silts to clays) with less than 1% organic matter. The heavier the soil (increased concentration of organic matter, clay, silt) the higher the rate of Velpar needed for control.
3. Do not apply to frozen or snow covered soil.
4. Foliar application to weeds is most effective under conditions of high temperature (27° C), high humidity and good soil moisture.
5. Application when vegetation is dormant may not be effective.
6. Because of injury to conifers, do not use in nurseries, seedbeds or ornamental plantings.
7. If used over top of conifers, do not use surfactant.
8. Do not use on trees which show poor vigour because of insects, disease, or winter injury or show symptoms of other stress conditions.

M.S.M.A.

1. Forked trees require individual treatment; M.S.M.A. does not translocate through root grafts.

SIMAZINE

1. Requires rainfall to be activated (chemical "washed into" root zone).
2. Do not apply when ground is frozen or covered with snow.

2, 4 - D

1. Avoid spraying if rain is expected shortly.
2. Less effective control during prolonged hot, dry weather.
3. General resistance of grasses to 2,4-D.

Additional Notes and Comments:

AMOUNT OF PESTICIDE PRODUCT (LITRES OR KILOGRAMS) REQUIRED TO PREPARE A 100 LITRE SPRAY SOLUTION TO APPLY AT VARIOUS SPRAY VOLUMES PER HECTARE (L/HA)

Product L/ha (or kg/ha)*	Equivalent Active Ingredients** (kg a.i./ha)					Total Solution to be Applied per Hectare (L/ha)***							
	Asulox F	2,4-D	Vision	Simazine	Velpar L	25	30	50	100	150	200	250	500
						Amount of product (L or kg*) required to prepare 100 litres of spray solution							
3.0			1.07			12.00	10.00	6.00	3.00	2.00	1.50	1.20	0.60
3.5			1.25			14.00	11.70	7.00	3.50	2.33	1.75	1.40	0.70
4.0			1.42			16.00	13.30	8.00	4.00	2.66	2.00	1.60	0.80
4.5			1.60			18.00	15.00	9.00	4.50	3.00	2.25	1.80	0.90
5.0		2.50	1.78			20.00	16.70	10.00	5.00	3.33	2.50	2.00	1.00
5.5	2.20	2.75	1.96	4.40		22.00	18.30	11.00	5.50	3.67	2.75	2.20	1.10
6.0		3.00	2.14	4.80		24.00	20.00	12.00	6.00	4.00	3.00	2.40	1.20
6.5		3.25		5.20		26.00	21.70	13.00	6.50	4.33	3.25	2.60	1.30
7.0		3.50		5.60		28.00	23.30	14.00	7.00	4.67	3.50	2.80	1.40
7.5		3.75		6.00		30.00	25.00	15.00	7.50	5.00	3.75	3.00	1.50
8.0		4.00		6.40		32.00	26.70	16.00	8.00	5.33	4.00	3.20	1.60
8.5		4.25				34.00	28.30	17.00	8.50	5.67	4.25	3.40	1.70
9.0		4.50			2.16	36.00	30.00	18.00	9.00	6.00	4.50	3.60	1.80
10.0		5.00			2.40	40.00	33.30	20.00	10.00	6.67	5.00	4.00	2.00
12.0					2.88	48.00	40.00	24.00	12.00	8.00	6.00	4.80	2.40
14.0					3.36	56.00	46.70	28.00	14.00	9.33	7.00	5.60	2.80
16.0					3.84	64.00	53.30	32.00	16.00	10.67	8.00	6.40	3.20
18.0					4.32	72.00	60.00	36.00	18.00	12.00	9.00	7.20	3.60
20.0						80.00	66.70	40.00	20.00	13.33	10.00	8.00	4.00

* Simazine is in kilograms, all others in litres Formula: (Litres or kg of product per ha *X* Tank Size / Spray Volume per ha)

** Recommended rates. Based on: Asulox F, 40% a.i.; 2,4-D, 50% a.i.; Vision, 35.6% a.i.; Simazine, 80% a.i.; Velpar L, 24% a.i.

*** For spray volumes/ha other than those shown , interpolate. For spray tank sizes other than 100 litres, multiply amount of product to prepare 100 litres by tank size/100

SPRAY AREA COMPUTATION TABLE OF AIRCRAFT SPEED AND SWATH WIDTH

Speed		Swath Width (m)														
kph	mph	9 30	10.5 35	12 40	13.5 45	15 50	16.5 55	18 60	19.5 65	21 70	22.5 75	24 80	25.5 85	27 90	28.5 95	30 m 100 ft
Hectares Sprayed per Minute = Swath width X kilometres per hour / 600																
64	40	1.0	1.1	1.3	1.4	1.6	1.8	1.9	2.1	2.2	2.4	2.6	2.7	2.9	3.0	3.2
72	45	1.1	1.3	1.4	1.6	1.8	2.0	2.2	2.4	2.5	2.7	2.9	3.1	3.2	3.4	3.6
80	50	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
88	55	1.3	1.6	1.8	2.0	2.2	2.4	2.6	2.9	3.1	3.3	3.5	3.8	4.0	4.2	4.4
96	60	1.4	1.7	1.9	2.2	2.4	2.6	2.9	3.1	3.4	3.6	3.8	4.1	4.3	4.6	4.8
104	65	1.6	1.8	2.1	2.4	2.6	2.9	3.1	3.4	3.6	3.9	4.2	4.4	4.7	5.0	5.2
112	70	1.7	2.0	2.2	2.5	2.8	3.1	3.4	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.6
120	75	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0
128	80	1.9	2.2	2.6	2.9	3.2	3.5	3.8	4.2	4.5	4.8	5.1	5.4	5.8	6.1	6.4
136	85	2.0	2.4	2.7	3.1	3.4	3.8	4.1	4.4	4.8	5.1	5.4	5.8	6.1	6.5	6.8
144	90	2.2	2.5	2.9	3.2	3.6	4.0	4.3	4.7	5.0	5.4	5.8	6.1	6.5	6.8	7.2
152	95	2.3	2.7	3.0	3.4	3.8	4.2	4.6	5.0	5.3	5.7	6.1	6.5	6.8	7.2	7.6
160	100	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0
168	105	2.5	3.0	3.4	3.8	4.2	4.6	5.0	5.5	5.9	6.3	6.7	7.2	7.6	8.0	8.4
176	110	2.6	3.1	3.5	4.0	4.4	4.8	5.3	5.7	6.2	6.6	7.0	7.5	7.9	8.4	8.8
184	115	2.8	3.2	3.7	4.2	4.6	5.1	5.5	6.0	6.4	6.9	7.4	7.8	8.3	8.8	9.2
192	120	2.9	3.4	3.8	4.3	4.8	5.3	5.8	6.2	6.7	7.2	7.7	8.2	8.6	9.1	9.6
200	125	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0

- This table shows the spray application rate in hectares per minute when the swath width and aircraft spraying speed are known.
- To find the rate of flow in volume per minute or weight per minute, multiply the hectares per minute figure by the volume or weight per hectare to be applied.
- To convert the hectares sprayed per minute into acres sprayed per minute, divide the figure by 0.4.
- Acres sprayed per minute can also be calculated by the formula: 2 X swath width in feet X miles per hour / 1,000
- 1 acre = 0.4 hectare; 1 mph = 1.6 kph; 1ft = 0.3 m.

SPRAY AREA COMPUTATION TABLE OF LENGTH AND SWATH WIDTH

Swath Length (m)	Swath Length (ft)	Swath Width (m) 9	10.5	12	13.5	15	16.5	18	19.5	21	22.5	24	25.5	27	28.5	30 m
		30	35	40	45	50	55	60	65	70	75	80	85	90	95	100 ft
		Hectares Covered = Swath Length X Swath Width (m) / 10,000														
100	330	0.09	0.11	0.12	0.14	0.15	0.17	0.18	0.20	0.21	0.23	0.24	0.26	0.27	0.29	0.30
200	660	0.18	0.21	0.24	0.27	0.30	0.33	0.36	0.39	0.42	0.46	0.48	0.52	0.54	0.58	0.61
300	990	0.27	0.32	0.36	0.41	0.45	0.50	0.54	0.59	0.64	0.68	0.73	0.77	0.82	0.86	0.91
400	1320	0.36	0.42	0.48	0.54	0.61	0.67	0.73	0.79	0.85	0.91	0.97	1.01	1.09	1.15	1.21
500	1650	0.46	0.53	0.61	0.68	0.76	0.83	0.91	0.98	1.06	1.14	1.21	1.29	1.36	1.44	1.52
600	1980	0.54	0.64	0.72	0.82	0.91	1.00	1.09	1.18	1.27	1.36	1.40	1.54	1.64	1.73	1.82
700	2310	0.64	0.74	0.85	0.97	1.09	1.21	1.33	1.46	1.48	1.59	1.70	1.80	1.91	2.02	2.12
800	2640	0.73	0.85	0.97	1.09	1.21	1.33	1.46	1.58	1.70	1.82	1.94	2.10	2.18	2.30	2.42
900	2970	0.82	0.96	1.09	1.23	1.36	1.50	1.64	1.77	1.91	2.04	2.18	2.32	2.46	2.59	2.73
1000	3300	0.91	1.06	1.21	1.36	1.52	1.67	1.82	1.97	2.12	2.27	2.42	2.58	2.73	2.88	3.03
1100	3630	1.00	1.17	1.33	1.50	1.67	1.83	2.00	2.17	2.33	2.50	2.67	2.83	3.00	3.17	3.33
1500	4950	1.36	1.59	1.82	2.04	2.27	2.50	2.73	2.96	3.18	3.41	3.64	3.86	4.09	4.32	4.54
2000	6600	1.82	2.12	2.42	2.73	3.03	3.33	3.64	3.94	4.24	4.54	4.85	5.15	5.46	5.78	6.06
2500	8250	2.27	2.65	3.03	3.41	3.79	4.17	4.54	4.92	5.30	5.68	6.06	6.44	6.82	7.20	7.58
3000	9900	2.73	3.18	3.64	4.09	4.54	5.00	5.46	5.91	6.36	6.82	7.27	7.73	8.18	8.64	9.09

This table shows the number of hectares covered in a swath of a given width and length. For swath widths other than those shown, interpolate or use combinations of the figures shown

To determine the amount of chemical required, multiply the hectares by the rate of application.

1 acre = 0.4 hectare; 1 mph = 1.6 kph; 1ft = 0.3 m (approx.)

To convert the hectares covered into acres covered, multiply the hectares by 2.5. Acres covered can also be calculated by the formula:

$$\frac{\text{Swath Length (ft) X Swath Width (ft)}}{43560}$$

Length	inches	25.40	millimetres
	inches	2.54	centimetres
	feet	30	centimetres
	feet	0.3048	metres
	yards	0.9	metres
	miles	1.6	kilometres
Area	square inches	6.5	square centimetres
	square feet	0.09	square metres
	acres	4046.7	square metres
	acres	0.4047	hectares
Volume	fluid ounces (Imperial)	28.41	millilitres
	fluid ounces (U.S.)	29.57	millilitres
	pints (Imperial)	0.57	litres
	quarts (Imperial)	1.1	litres
	gallons (Imperial)	4.546	litres
	gallons (U.S.)	3.785	litres
Weight	ounces	28	grams
	pounds	0.45	kilograms
Temperature	(F° - 32)	0.56	°C
Application Rate	lb./acre	1.12	kg/ha
	gal./acre (Imperial)	11.2	L/ha
	gal./acre (U.S.)	9.35	L/ha
Speed	ft./sec.	0.3	m/sec.
	m.p.h.	1.6	kph
Pressure	p.s.i.	6.9	kPa
Flow Rate	Imperial gallons/hour (gph)	4.545	litres/hour (L/hr)
	Imperial gallons/min. (gpm)	4.545	litres/min. (L/min.)
	U.S. gallons/hour (gph)	3.785	litres/hour (L/hr)
	U.S. gallons/min. (gpm)	3.785	litres/min. (L/m)

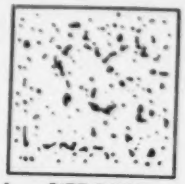
SECTION D

Monitoring and Project Evaluation

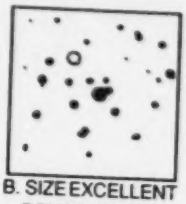
HERBICIDE PROJECT MONITORING PLAN CHECKLIST

Items	Aerial Spraying	Spot Gun (Soil Spraying)	Surface & Basal Treatments	Ground Broadcast Spraying	Roadside Spraying
Compliance with Label Instructions	☐	☐	☐	☐	☐
Mixing and Loading Site	☐	☐	☐	☐	☐
Calibration of Application Equipment	☐	☐	☐	☐	☐
Mixing of Herbicide	☐	☐	☐	☐	☐
Loading of Herbicide into Spray Equipment	☐	☐	☐	☐	☐
Leaks in Equipment	☐	☐	☐	☐	☐
Weather Conditions Compliance	☐	☐	☐	☐	☐
Rate of Application	☐	☐	☐	☐	☐
Maintenance of Buffer Strips	☐	☐	☐	☐	☐
Spray Coverage	☐	N/A	N/A	☐	☐
Flight Pattern	☐	N/A	N/A	N/A	N/A
Flight Time	☐	N/A	N/A	N/A	N/A
Total Amount of Formulation Used	☐	☐	☐	☐	☐
Storage and Handling of Herbicide	☐	☐	☐	☐	☐
Container disposal	☐	☐	☐	☐	☐
Mixing and Loading Site Clean-up	☐	☐	☐	☐	☐
Application Records	☐	☐	☐	☐	☐
Compliance with Permit Conditions	☐	☐	☐	☐	☐
Compliance with Contract Conditions	☐	☐	☐	☐	☐
Additional Conditions	☐	☐	☐	☐	☐

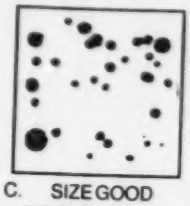
HERBICIDE SPRAY PATTERNS



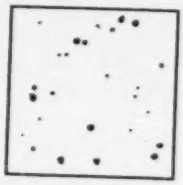
A. SIZE GOOD
DENSITY EXCELLENT



B. SIZE EXCELLENT
DENSITY GOOD



C. SIZE GOOD
DENSITY GOOD



D. SIZE GOOD
DENSITY FAIR

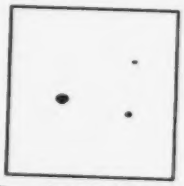
PUNCH
OUT HERE

ONE SQUARE
INCH

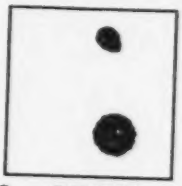
PROCEDURE:

- place spray deposit card beneath this page.
- compare spray deposits with examples from this page.
- record evaluation.

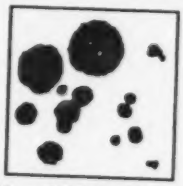
E. IDEAL PATTERN
FOR NON-TARGET
AREAS



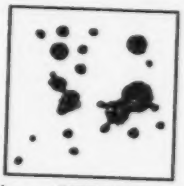
F. SIZE GOOD
DENSITY POOR



G. SIZE FAIR
DENSITY POOR

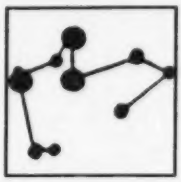


H. SIZE POOR
DENSITY GOOD

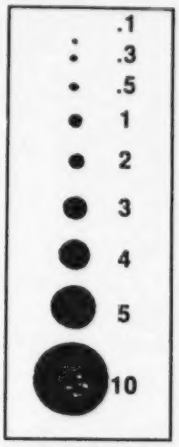


I. SIZE FAIR
DENSITY FAIR

J. SIZE POOR
DENSITY POOR



METHOD FOR
COUNTING DOTS



DROPLET SIZE
(millimetres)

Ideal Patterns

- 70 or more droplets per sq. in.
- most droplets 0.7 to 2.2 mm
- no droplets > 7 mm
- few droplets < .3 mm
- outside buffer zone, no droplets on non-target area cards.

Source: Modified from; Handbook on Aerial Application of Herbicides. USDA Forest Service (1983) R-5 FSH 2109.21

RECORD KEEPING

Refer to B.C. Forest Service Form Number FS 705:
Herbicide Operation Record

EFFECTIVENESS EVALUATION

Refer to B.C. Forest Service Form Number FS 706:
Vegetation Management Post-Treatment Evaluation:
Treatment Effectiveness

SECTION E
Safety Precautions Relating to Herbicide Use

OPERATION	Equipment Used	Boots[b]	Pants[c]	Jacket[c]	Hood or Hat[d]	Gloves[e]	Face Shield or Goggles[f]	Respirator[g]	Ear Protectors[h]
Handling, loading, mixing and filling of herbicides	All Types	E	E	E	E	E	E	E3	n/a
Solid Materials (granules, crystals, dust) applications	1. Gravity/ Placement	E	E1	D	D	E	D	E3	n/a
	2. Motorized	E	E1	D	D	E	E	E	E
Medium Vol. Spraying	Backpacks	E	E1	E1	D	E	D	E4	n/a
Low Volume Spraying	Motorized Mistblowers	E	E	E	E	E	E	E4	n/a
Ultra Low Volume Spraying	Herbi and Spot Herbi	E	E	E	E	E	E	E4	n/a
Spot Application	Spot Guns	E	E1	E1	D	E	D	D	n/a
Spraying with vehicle mounted fixed boom	1. Tractor/truck	D	E1	E1	E	E	E	D	E
	2. Tractor without cab	E	E	E	E	E	E	E	E
Spraying with gun and hose pulling (handling)	Vehicle Mounted Sprayers	E	E	E	E	E	E	D	D
Stem Basal Treatment	All Types	E	E	E	E	E	E	D	n/a
Tree Injection	1. Hack & Squirt	E	E1	E1	D	E	D	D	n/a
	2. Lance	E	E1	D	D	E	D	D	n/a
	3. Capsule or shell	D	D	D	D	E	D	n/a	D

MINIMUM PROTECTIVE CLOTHING AND EQUIPMENT REQUIRED FOR HERBICIDE USE IN FORESTRY (CONT.)

OPERATION	Equipment Used	Boots[b]	Pants[c]	Jacket[c]	Hood or Hat[d]	Gloves[e]	Face Shield or Goggles[f]	Respirator[g]	Ear Protectors[h]
Ground marking /flagging (aerial)	Aircraft	E	E	E	E	E	E	D	D
Flying (pilots)	Aircraft	D	D	D	D	D	D	n/a	n/a
Exiting from aircraft cockpit, (not affecting repairs)	Aircraft	D	D	D	D	D	D	n/a	n/a
Equipment cleaning & repair	Aircraft	E	E	E	D	E	E	D	n/a
Empty container rinsing, handling and disposing	All types	E	E	E	D	E	E	D	n/a
Exiting from cab	Spray Vehicle	D	E1	E1	D	E	D	n/a	n/a
Re-entry to spray area before spray is dry	All	E	E1	E1	E2	E2	E2	D	n/a

Notes:

D Desirable - To be used when there is noticeable exposure to herbicides or excessive noise or as directed by the operator's supervisor.

E Essential in relation to working conditions in forestry.

E1 Pants, jacket/long sleeved shirt made of cotton/polyester mix material essential as minimum for operator protection in low brush situations. Additional protection may be required in unusual circumstances or as directed by the operator's supervisor.

E2 Essential for high brush site. Discretionary for low brush situation if spray droplets are settled.

E3 Respirator to be used when handling or applying powders, dusts, crystals or granules. Respirator may also be required under certain circumstances of handling, loading, mixing, filling and applying undiluted liquid herbicides when there is a likelihood of herbicide inhalation. Respirator not required for normal use and handling.

E4 Respirator to be used when spraying herbicides in an enclosed space. Respirator may also be required when there is a likelihood of herbicide inhalation or as directed by the operator's supervisor.

n/a Not applicable.

[a] This guide applies to all herbicides (eg 2,4-D amine, 2,4-D ester, glyphosate, hexazinone, simazine, asulam, MSMA) which are currently registered for use on forests and woodlands in Canada. Protective equipment must ensure that operators are not exposed to harmful quantities of herbicides due to drift, contact with sprayed foliar surfaces, spillage or other sources of exposure.

[b] Water resistant boots. Knee high type preferred. Unlined rubber boots should be used when mixing or handling concentrates. Leather or canvas footwear should not be used.

[c] Long legged pants and jackets. Coveralls may be used instead of a combination of Pants and Jackets. The general recommendation is to use waterproof or oil-proof materials (depending upon the chemical or spray mix used), except where noted by E1. The legs of the coverall/pants should be worn outside the boots, and the sleeves of the jacket outside the gloves, in situations where the spray is being directed downward. A chemical apron may be used for chemical handling, mixing and filling or cleaning of equipment.

[d] Water/oil resistant hood or full wide brimmed hat. Cloth sweatbands, headbands or liners, and baseball caps should not be used as they absorb herbicides. Though the use of hard hat may be discretionary for some herbicide activities, British Columbia Workers' Compensation Board (WCB) requires that "safety headgear shall be worn by workers in all areas in which a potential hazard to the head exists from falling, flying or thrown objects or from other harmful contacts".

[e] Chemical resistant unlined plastic (neoprene) gloves.

[f] Faceshield or splash goggles are essential when spraying with hexazinone; Faceshield is the preferred method if you wear glasses.

[g] Filtering facepiece respirator. Where a respirator is required or requested, a respirator with a well fitted facepiece equipped with a filter pad is adequate for droplets of water solutions of herbicides provided that no chemical vapours arise from the water solution droplets. When chemical vapours are released from solutions of herbicides (e.g. oil spray), or if the herbicide has an objectionable odour, the respirator must be fitted with a filter and an organic vapour cartridge.

[h] Ear protectors are essential where motorized equipment leads to excessive noise.

Additional Notes:

[*] When the applicator is operating from an enclosed aircraft cockpit or an enclosed vehicle compartment to which forced air ventilation units complete with approved spray filter have been fitted, then none of the listed items need be worn when spraying herbicides.

[**] The Contractor or his designated authority is responsible for ensuring that these requirements are met. For projects undertaken by the Forest Service (Ministry of Forests) staff the supervising Ministry Officer is responsible for ensuring that these requirements are met.

[***] Herbicide label restrictions take precedence over the recommendations in this table when label restrictions are more limiting.

References:

Wittering, W.O., 1974. Weeding in the Forest. A Work Study Approach. Forestry Commission Bull. No. 48, HM Stationary Office, London, 68 pp.
Tabbush, P.M. and Lane, P.B., 1983. The Use of Herbicides in the Forest. Forestry Commission Bull. No. 51, 110 pp.
Cantrell, R.L., 1985. A Guide to Silvicultural Herbicide Use in the Southern United States. Auburn University, Alabama
Matthews, G.A., 1983. Pesticide Application Methods. Longman, N.Y., 336 pp.

Material	Immediately After Contamination	After Each Day's Work
A. Gloves	Contamination with undiluted herbicide should be thoroughly washed with water within 10 minutes.	1. Wash inside and out with soap or detergent & water 2. Rinse thoroughly with clean water 3. Wipe inside and out and allow to dry thoroughly. Avoid extremes of heat and direct sunlight when drying.
B. Rubber Boots	Wash off with water	1. Wash outside with water 2. Allow inside and outside to dry.
C. Water or oil proof pants, jackets & coveralls	***Grossly*** contaminated areas should be rinsed well with *water* only. (NB: neoprene material may become swollen and tacky with soapy water and some herbicides).	Wash with soap and water
D. Respirators		1. Clean with water and mild detergent. 2. Sterilize after cleaning with household disinfectant.

*Do not attempt to wash disposable chemical respirators, gloves or clothing.

RECOMMENDATIONS FOR LAUNDERING OF HERBICIDE CONTAMINATED CLOTHING

GENERAL

1. Read the herbicide label before you start.
2. Always include a laundry activity with your herbicide use plan.
3. Wash contaminated clothing as soon as possible since residues are easier to remove when not allowed to dry.
4. Washing of laundry is necessary at the end of each day's herbicide use after the application equipment has been cleaned and stored.
5. Use heavy duty or phosphate-based detergent. Do not use bleach and ammonia. They are ineffective in removing pesticide contamination. (Bleach and ammonia react to form a poisonous chlorine gas).
6. Use disposable pesticide clothing to provide extra protection during washing.
7. If the clothing is thoroughly contaminated, do not wash it. Discard it in the appropriate and safe manner.
8. Wash contaminated materials separately from family laundry.
9. Wash only a few clothing at a time.

STEPS

1. Pre-rinsing of clothes
   a) Pre-soak in a suitable container (washer, tub, or bucket) or by spraying clothing outdoors in a safe manner with a hose.
   b) Agitate in an automatic washing machine.
2. Wash with plenty of water. Set laundry machine at the hot (60° C) and full water levels, and normal (12 minute) washing cycle.
3. Repeat washings twice or thrice.
4. Line dry washed laundry. To avoid contamination do not use automatic dryer.
5. Cleaning of washing machine after use:
   a) Rinse the washing machine thoroughly after laundering contaminated clothing. The machine must be run empty (without laundry) at the same settings (hot water, full water, normal washing) used to launder the clothes.
   b) Wipe the inside with rubbing alcohol (isopropyl alcohol) for added protection.

Reference: Easley, Carol Bryan, Joan Laughlin and Roger Gold. 1984. Laundering Pesticide Contaminated Clothing. Pennsylvania Flower Growers Bulletin. Jan. 1984; pp. 15-16

GENERAL

1. Read the label, including the small print and follow its recommended safety practice.
2. Never work alone when handling the most toxic chemicals. A minimum of one person with a Forest Applicator's Certificate will be on the project at all times.
3. Wear the appropriate clothing for the intended job. If contaminated, remove and replace with clean clothing.
4. Select the correct equipment for the intended use.
5. Take only the necessary quantities of herbicide to the field.
6. Store herbicides in dry and secure place in the field. (Never leave herbicides unattended or unlocked.)
7. Avoid skin and eye contact. Avoid breathing mist if generated. Provide eye fountain near work place.
8. Do not transfer herbicides into other containers such as beer and soft drink bottles.
9. Always have plenty of water, soap and towel, and a change of clean clothes available.
10. Keep children or other unauthorized persons, pets and livestock out of the mixing, loading or storage sites, and areas in which application is in progress.
11. Select sites for storage, loading, and cleaning of equipment that will prevent contaminating streams, ponds, cisterns, food stocks, crops adjacent to work sites, or other non-target areas. Never allow puddles or pools of herbicide to form.
12. Wash hands with soap and water before smoking, handling food and drink, or attending to personal needs. Do not eat, drink or smoke while applying, mixing or handling herbicides. Remove protective clothing and wash well before eating and drinking.
13. Clean up spilled chemicals at once.
14. Repair any leak in the spray distribution system or in the mixing equipment as soon as it is detected. Never blow out clogged nozzles or hoses with your mouth.
15. Sign the herbicide treatment area to prevent/inform people entering the site.
16. Pick up and safely dispose of (or deliver to pickup depot) all empty herbicide containers immediately after use. Never stand in the smoke where containers are being burnt.

MIXING AND LOADING OF HERBICIDES

1. Do the mixing outdoors. Indoor mixing or loading must be done only in areas with adequate lighting and ventilation.
2. Calculate accurately the correct quantity of the herbicide product needed. Always add the concentrate to the carrier - Never the carrier to the concentrate.
3. All measuring and mixing containers should be reserved solely for these purposes.

4. Use a knife when opening paper containers. Do not tear with hands.
5. Always keep containers below eye level when pouring herbicides.
6. Do not point container spout towards the face when opening containers.
7. Attend to sprayer tanks when filling to avoid overflowing and spilling of herbicides on the ground.
8. Rinse empty liquid containers three times into spray tanks. Tap sides of paper bags to ensure that any remaining wettable powder falls into the spray tank.
9. Always stand upwind when mixing.
10. Mixing must be done or supervised by a certified person(s).

AERIAL HERBICIDE APPLICATION

Personnel Safety

1. Unless authorized by the pilot, stay away from a helicopter when rotor blades are in motion. Stay at least 15 metres away from small helicopters, and 30 metres away from large helicopters.
2. When within 15 metres of the helicopter, approach or leave from front or side near front and within view of the pilot.
3. Never approach or leave the helicopter from any side where ground is higher.
4. Stay away from tail rotor at all times, and see that others do likewise.
5. Place caution signs on approaches to active heliports/airstrips.

Ground Crew:

1. Close tanks and hoppers tightly after filling.
2. Should not stand in pesticide-contaminated run-off water.
3. Clean aircraft, especially the cockpit, frequently.
4. People should be on site until spraying is completed so that help can be given to the pilot in case of accident.

Flagmen:

1. Should move over to the next position when the aircraft is lined up for a pass.
2. Should avoid turning his back on an approaching aircraft.
   * (Use of permanent markers and automatic flagmen are recommended. They eliminate the possibility of harm to flagmen).

Project Safety

1. Arrange spraying schedules so that poor visibility before and shortly after sunrise will not seriously affect the safety of the operation.
2. Do not permit spraying upgrade when the climb required exceeds one-half the climbing ability of the helicopter.
3. Ensure that all reconnaissance flights are performed with spray tanks empty, and at an altitude of not less than 90 metres above the ground.

Visitors

1. Visitors to the application project will be kept in a safe area.

Pilot Safety

1. Caution pilots about snags and standing trees, location of downdrafts, and telephone and hydro lines.
2. The pilot will not fly in fog, heavy rain, before daylight or after dark.
3. A wind indicator of plastic ribbon or similar material should be placed near each heliport. The target area and surrounding should be checked for drift hazards before application.
4. The pilot in command will be responsible for the safety of the aircraft, its occupants, and cargo. The pilot must not fly in a manner or at a time which may create a hazard, even if the employer insists.
5. The pilot should make preflight aircraft check.
6. The pilot should avoid flying through spray or drift if possible.
7. The pilot shall not apply herbicides over flagmen or other persons.

GROUND VEHICLE APPLICATION

1. While applying herbicide, do not cross open water (streams, ponds etc.) with ground spray equipment.
2. Thoroughly clean and rinse spray equipment after project completion.

HACK AND SQUIRT APPLICATION

1. All crew members should receive orientation on the use, handling, and application of the chemical, care of the applicator equipment, along with on-the-job training.
2. All contacts with the chemical (accidental spillage), will be reported to the supervisor.
3. Unlined rubber gloves should always be worn when applying herbicide.
4. Hands will be washed with soap and water prior to smoking or eating and at the end of the day's work. A complete change of clothing should be made daily.
5. All paper towels used after washing will be placed in a plastic bag for disposal.

BACKPACK APPLICATION

1. All crew members should receive instructions on the mixing, loading and application of the chemical, equipment maintenance, and safety gear.
2. All crew members should be informed of the boundaries of the treatment area, including buffer zones surrounding streams or waterbodies.
3. It is recommended that a hard hat with face shield, rubber boots, unlined rubber gloves and waterproof coveralls (or long pants and jacket) be worn.

4. Sprayers and hoses should be checked for leaks.
5. Inhalation of spray mist and any contact with the herbicide should be avoided.
6. Proper calibration of the equipment is necessary.
7. Drift of the spray outside the treated area is to be avoided. Do not spray if wind speed exceeds 8 km/hr.

STORAGE, TRANSPORTATION AND DISPOSAL OF HERBICIDES

STORAGE

It is necessary that herbicides be stored in a safe, secure, (under lock and key), and well marked area. (Technical & Administrative Services Branch of the Ministry has specifications for Pesticide Storage and Mixing Buildings). A current inventory of the stored herbicides should be maintained at a separate location, so that in the event of a fire, firemen will be able to determine what materials are involved. Notify local fire stations of the contents of all herbicide storage facilities.

1. All storage areas should have warning signs posted nearby, identifying a herbicide storage facility. Keep all herbicides away from animals and unauthorized people.
2. Always store herbicides in their original, labeled container, which should be tightly sealed. Containers holding unused diluted material must be labelled.
3. Manufacturer's labels and leaflets must be retained for reference.
4. Other containers especially old food containers or bottles should not be used to store herbicides.
5. Avoid eating, drinking, smoking or use of any tobacco products in the storage area.
6. Herbicides should never be stored near food, feed or seed, water supplies or near highly flammable materials, such as gasoline or solvents, or with any other pesticides.
7. The storage area (building) should be well ventilated, and protected from excess heat (including sparks and fumes) or freezing temperatures. The storage area should be equipped with a sump for handling minor spills and leakages. An earthen dike or similar structure may be constructed around the building to contain large spills or run off (in the event of a fire).
8. A cupboard should be available for the storage of personal protection equipment (clothing, boots, gloves, respirators), separate from the herbicide storage area. Store all containers (utensils) used in the mixing operation in this reserved location.
9. Emergency shower and eye wash station should be nearby.

10. Check containers periodically for leakage, spillage, corrosion, tear, or other signs of deterioration. Faulty containers must be disposed of.
11. Have an emergency spill kit. Also maintain contingency plans and instruct personnel on proper emergency procedures.

TRANSPORTATION

Herbicides can present a particularly severe hazard if they are involved in accidents during transportation. When herbicides are spilled on the roadway, they may catch fire, be scattered by passing cars or trucks, be blown by wind onto nearby crops or people, or be washed into ditches or streams by rain. If they catch fire, the fumes and smoke may injure firefighters, or police, ambulance personnel. Herbicides may contaminate the vehicle, cargo, or people transporting the chemicals. When transporting herbicides, the carrier is legally responsible for their safekeeping and all required warning signs. The shipper must comply with regulations respecting the Transportation of Dangerous Goods Acts, where applicable.

The following precautions should be taken:

1. Herbicides should be transported in the back of a truck (never the passenger compartment), and locked up if unattended.
2. Never allow anyone to ride in the back of a truck containing herbicides.
3. Food, feed or clothing must not be transported in the same compartment as herbicides.
4. Transport herbicides in their original, labelled containers. Should it be necessary to m[illegible] herbicides prior to transporting, a licensed applicator should accompany the delivery.
5. All herbicide containers should be secured during transport to prevent spillage.
6. Herbicide containers made of paper or cardboard should be protected from moisture.
7. Herbicide containers made of glass should be protected from breakage.
8. Containers should have the correct labels.
9. Before loading or unloading check containers for damage.
10. Park the vehicle in shade or move herbicides to shaded area to avoid pressure buildup under the containers.
11. Do not leave vehicles unattended or unlocked.
12. Herbicide first aid and spill kits should be stored in the vehicle and available at all times in the event of an accident.

DISPOSAL

Those who use herbicides are responsible for ensuring that all empty herbicide containers, surplus containers and excess herbicide are disposed of safely and promptly. Waste chemicals and containers should be considered hazardous to the public and to people handling them. When improperly handled, these materials are potential pollutants of the environment. Consult herbicide manufacturers, the Pesticide Control Branch, or the regional office of the Environmental Protection Service, Environment Canada, for special instructions regarding disposal of specific chemicals.

CONTAINERS

Empty containers should be securely held in a proper storage building until disposal. A regular disposal system is necessary - empty containers should not accumulate. Empty containers must not be reused for other purposes. They should not be left on the job site.

Glass, Plastic and Metal Containers

Empty containers into the application equipment. Allow container to drain for 30 seconds. Triple rinse the container with water (or other appropriate carrier). The container should be one-fourth to one-fifth full with the rinse solution for each washing. For each rinse, replace the cap of the container and rotate the container. Invert or tilt the container so the rinse reaches all the inside surfaces. All interior surfaces should be thoroughly rinsed. Place the washings back into the application device. Let the container drain for 30 seconds. Apply washings to the treatment area. Do not use container for any purpose. Puncture or crush the container so that it cannot be reused. Where applicable send empty containers to the manufacturer/distributor for recycling.

"Returnable" Containers

Empty containers must be delivered to manufacturer's designated depot.

Paper or Cardboard Containers

Containers should be completely emptied.
Cut the container so they cannot be reused.
All containers, after being rendered useless (crushed or punctured), should be disposed of at approved landfills or buried in accordance with federal and provincial laws and regulations:

(a) in deep soil and at least 2 - 3 metres from bedrock, where lateral subsurface water movement may occur;
(b) on relatively high ground, flat or gently sloping away from any water supply;
(c) at least 150 metres away from livestock feeding areas, wells or streams, such that water supplies will not be contaminated.

CLEANING AND STORAGE OF SPRAYERS

Check the product label for specific cleaning instructions and recommendations for disposing of the rinsings. Wear rubber gloves and other safety gear when decontaminating a sprayer. Sprayers would be thoroughly cleaned immediately after application of each type of pesticide or when there is a buildup of oil in the sprayer, and at the end of the season. While cleaning the sprayer at the end of the season, add 10 - 15 litres of light weight oil during the final flushing to leave a protective coating as the water is pumped out.

CLEANING

Oil Based Products
(e.g. esters of 2,4-D and other phenoxy herbicides)

1. Rinse sprayer with kerosene, diesel fuel or a comparable light oil.
2. Fill the tank about one third full of a water and ammonia solution (1 litre ammonia to 110 litres water) provided there are no brass components, or with water and TSP solution (1 cup trisodium phosphate in 110 litres water).
3. Circulate the mixture throughout the system. (See that the agitation system on motorized equipment is working during this operation).
4. Spray some solution through the nozzles and let the remainder stand at least 6 hours before pumping it throughout the nozzles.
5. Remove the nozzles and screens and clean tips and strainers with a soft-bristle brush (e.g. tooth brush).Flush the system twice with clean water.

Wettable Powders, Amines and Water Soluble Liquids

1. Rinse tank with water and detergent solution (1 kg detergent in 180 litres of water).
2. Allow solution to circulate through the system for several minutes before pumping it out. (see that the agitation system on motorized equipment is working during this operation).
3. Remove the nozzles and strainers and clean with a soft bristle brush before flushing the system twice with clean water.

Additional Information

1. Take care to avoid contaminating drinking water supply and other water sources, or injuring non-target plants.
2. Best cleaning area is in the vicinity of the treatment unit.
3. Do not remove protective clothing until equipment is cleaned and stored.
4. Never place nozzles in your mouth to blow through the orifice.

SPRAYER STORAGE AFTER CLEANING AND DRAINING

1. Make complete check of the pump and where applicable, the engine before storing the sprayer.
2. Store the sprayer in a clean, dry building kept locked away from children, food and animals.
3. If sprayer is stored outside, remove all hoses, wipe them clean of grease and oil and store them inside where they are less exposed to stretching and cracking caused by moisture and temperature changes.
4. Close the nozzle openings and hose connections with masking tape and seal the hose parts in the pump with a rag to keep out dirt and dust.
5. Remove the nozzle tips and screens and store them in a can or jar of diesel fuel.
6. Release the tension on the drive belt, remove the hoses leading into and out of the casing and remove the drain plug from the bottom of the casing.
7. Preferably, store small hydraulic sprayers upside down with the lid removed to allow complete drainage of the container.
8. For a prolonged period of storage of engines remove the spark plug and pour a small quantity of oil (preferably that formulated with anti-rust additives) into the crank case.

INCOMPATIBILITY OF 2,4-D, VELPAR L AND VISION WITH SPECIFIC MATERIALS

2,4-D

- incompatible with acids, bases, and oxidizing materials

Velpar L

- incompatible with strong acids and bases

Vision

- incompatible with galvanized or unlined steel containers. Vision reacts with steel and the resulting gas mixture can flash ignite or explode. **Vision should be mixed and applied only in stainless steel, aluminum, fibreglas, plastic and plastic lined containers.**

SHIPPING INFORMATION FOR VELPAR L, VISION AND 2, 4 - D HERBICIDES *

	Velpar L (Hexazinone)	**Vision (Glyphosate)**	**2, 4 - D (e.g. 2, 4 - D Formula 40F; Esteron 600)**
SHIPPING NAME	Ethanol Solution Agricultural Herbicide	Weed Killing Compound N.O.I.B.N.	Environmentally Hazardous Substance (2, 4 - D)
TDG HAZARD CLASS	3.3	Not Regulated	9.2
PRODUCT IDENTIFICATION NUMBER (PIN) / UN #	1170	-	None
TDG LABEL	Flammable Liquid		
PACKING GROUP	III	-	III
SPECIAL INFORMATION	Flash Point: 23° C		

* Under the Transportation of Dangerous Goods Act (Canada) (TDG)

SECTION F
Handling Emergency Situations

FIRST AID KIT: HERBICIDE USE

- B.C. First Aid Kit
- Detergent or soap to wash herbicides off the skin
- Syrup of Ipecac (or salt) for inducing vomiting
- Activated charcoal to mix with water and swallow to act as herbicide absorber
- Plastic airway to use for mouth to mouth resuscitation
- Distilled water
- Band-Aids, bandages and tape
- Blanket to cover victim
- Collapsible water container
- Drinking cups
- Coins for telephone call, or radios (with extra radio batteries)
- Change of clothing
- Lemon juice or vinegar to neutralize basic or alkaline chemicals if swallowed
- Baking soda or milk of magnesia to neutralize acidic chemicals if swallowed
- Teaspoon, tongue blades (wooden sticks)
- List of emergency phone numbers

In addition, the following should be available:

- Eye washes
- Wash & cleanup area
- Scrub brush
- Nail file
- Skin lotion
- Herbicide label
- Material Safety Data Sheet for the Herbicide(s)
- W.C.B. Pamphlet "Protecting Your Skin"

Notes:

1. First Aid Kit should be carried to the project site.
2. Any person regularly involved in applying pesticides should have a routine medical examination.

HERBICIDE SPILL KIT

- Instructions for Spills
- Emergency Telephone Numbers
- Agricultural white lime
- Kitty litter (20 kg bags)
- Large plastic garbage bags
- Shovels
- Nutrasol
- ABC Type Fire Extinguisher
- Polyethylene or plastic tarp
- Dustpan and shopbrush
- Flagging and Rope
- Herbicide First Aid Kit
- Personal Protective Safety gear

FIRST AID: GENERAL PROCEDURES FOR HERBICIDES

GENERAL

1. Stop the exposure by separating the person from the source of exposure.
2. Administer the appropriate first aid, artificial respiration etc.
3. Transport the victim, with a readable label or the name of the chemical, to a doctor or hospital emergency room.

EXPOSURE

1. Skin Contact

(a) Act quickly
(b) Contaminated clothing should be removed.
(c) Skin, hair, and fingernails should be thoroughly washed with soap and water. Speed is important in reducing injury.
(d) Dry victim, and wrap in blankets.
(e) Transport victim to medical treatment.

2. Eye Contact

(a) Hold eyes open, wash eyes with gentle stream of clean (chemical or drug free), running water for 15 minutes or more.
(b) Use copious amounts of water.
(c) Victim should receive medical attention.

3. Inhalation

(a) If victim is in enclosed space, do not go in after him without air-supplied respirator.
(b) Carry patient (do not let him walk) to fresh air immediately.
(c) Loosen all tight clothing.
(d) Apply artificial respiration if breathing has stopped, or is irregular.
(e) If patient is convulsing, monitor his breathing, ensure that he does not strike his head on the wall or floor, and keep his chin up to unblock his air passage. A strong piece of wood or a folded handkerchief should be placed between his teeth to prevent him biting his tongue.
(f) Do not give alcohol in any form.
(g) Keep patient wrapped in a blanket to prevent chilling, and as quiet as possible while being taken to medical attention.

4. Ingestion

(a) Call a physician immediately.
(b) Check the label to see if vomiting is recommended, or an antidote should be administered.
(c) If vomiting is recommended, induce vomiting unless the patient is unconscious, or in convulsions.
(d) Vomiting can be induced by tickling the back of the throat with a clean finger, or placing the blunt end of a spoon at the back of the throat, or drinking 2 tablespoons of salt in a glass of warm water.

FIRST AID: GENERAL PROCEDURES FOR HERBICIDES (CONT.)

(e) Collect a sample of vomit for chemical analysis.

(f) Do not induce vomiting if petroleum products (emulsifiable concentrates or oil solution) or corrosive poisons (strong alkali or acid) have been swallowed.

(g) If the patient can swallow, administer:

- for acid ingestion - milk, water or milk of magnesia
- for alkali ingestion, 1 - 2 cups of milk or water for children under 5 and up to 1 litre for adults.

5. Chemical Burns

(a) Remove contaminated clothing.

(b) Wash skin with large quantities of running water.

(c) Cover the burn with loosely applied clean cloth.

(d) Avoid use of ointments, greases, powders or other drugs.

(e) Treat for shock by keeping the patient lying down, warm, and reassured until arrival of physician.

GENERAL PROCEDURE FOR HERBICIDE SPILLS AND LEAKS

IN THE EVENT OF A HERBICIDE SPILL ON-SITE:

1. Ensure all staff are aware of the location, size and extent of the spill.
2. Any person contaminated by the spill should be treated for herbicide exposure.
3. Observe fire and explosion hazards and safety precautions before and during clean-up. Wear the appropriate personal protective and safety gear for clean-up (eg rubber boots and gloves).
4. Stop the source of the spill (a leaking tank etc.). Separate leaking containers for non-leakers.
5. Use the B-A-N system (Barricade, Absorb, Neutralize). Barricade or dike the spilled herbicide with soil to prevent its spread, especially into water-ways.
6. Do not hose down the area. For dust or powder material dampen it with fine water spray and cover it with a tarp.
7. Absorb or soak up as much liquid material as possible. Spilled herbicides should be covered with double their volume of absorbent material such as clay soil, hydrated lime, vermiculite, cat litter, or other commercial absorbents. Flammable materials such as sawdust, rags, and paper are less desirable. For spills on impervious surfaces, collect contaminated absorbent, place in plastic lined metal drum and dispose of according to federal and provincial lays and regulations.

8. Neutralize any remaining residues and contaminated tools, vehicle etc., with a solution consisting of 1 litre sodium hypochlorite (bleach) plus 1 cup detergent in 8 litres water; or 5 percent sodium carbonate (washing soda) solution plus detergent; or 5 percent trisodium phosphate (TSP) solution plus detergent. Scrub equipment thoroughly and follow with a clean water rinse.

Caution:

Do not use bleach to treat acidic pesticides such as glyphosate. Dangerous chlorine gas is given off when bleach is mixed with acidic materials.

If there are large amounts of contaminated material, use a mechanized loader to minimize human contact. Carry debris to disposal site in tightly sealed containers.

Ground contaminated with herbicides should be scraped to a depth of 15 cm, disposed of with the rest of the debris, and covered with uncontaminated soil. The disposal site should be away from ground or surface water, well above the water table. Cover the bottom of the pit with lime. Place debris in the pit, adding lime throughout. Cover with at least 1 metre of soil, compact, and build up soil over pit.

MAJOR SPILLS

1. Keep people away.
2. Give first aid if needed.
3. Confine the spill.
4. Call the local fire department and pesticide authorities for help. For spills on the highway, call the highway patrol or the police also. All spills should be noted on the Herbicide Operation Record, and reported to the District Office.

CONTAINER LEAKS

1. Separate leaking containers from the non-leaking.
2. Transfer the leaking container or its contents to a plastic-lined drum or other non-leaking container and dispose of according to federal and provincial laws and regulations.

Sources:

First Aid

Adams, R.W., 1987. Handbook for Pesticide Applicators and Dispensers. Pesticide Control Branch, B.C. Ministry of Environment and Parks, Victoria, B.C. 248 pp.

Singer J. 1980. Pesticide Safety Guidelines for Personal Protection. U.S.D.A. Forest Service Davis, ca. 45 pp.

Herbicide Spill Kit

Adams, R.W., 1987. Handbook for Pesticide Applicators and Dispensers. Pesticide Control Branch, B.C. Ministry of Environment and Parks, Victoria, B.C. 248 pp.

Southwell, P.H. and G.S. Cooper 1973. Handbook on Chemical Safety in the Aerial Application of Chemical Material. Report prepared for National Health and Welfare. Information Canada, Ottawa 132 pp.

Procedures for Herbicide Spills

U.S. Forest Service 1979. Final Environmental Statement. Silvicultural Treatments with Herbicides. North Idaho National Forests. U.S.D.A. Forest Service 294 pp.

	Vision	Velpar L	Esteron 600 (2,4-D Ester)	For-Ester (2,4-D Ester)	Formula 40 (2,4-D amine)	Forestamine (2,4-D amine)
INHALATION		Remove patient to fresh air. Artificial respiration if patient not breathing. Difficult breathing: give oxygen. Call physician.*	Remove patient to fresh air. If effects occur consult physician.	Same as Esteron 600.	Same as Esteron 600.	Same as Esteron 600.
SKIN CONTACT	Flush skin with water**	Flush skin with water.	Wash off in flowing water or shower.		Remove contaminated clothing or shoes. Flush skin with water.	
EYE CONTACT	Immediately flush eyes with water. Call a physician.	Same as Vision.	Same as Vision.	Same as Vision.	Same as Vision.	Same as Vision.
INGESTION	Do not induce vomiting. Drink copious amounts water, milk or any potable liquid. Call physician.	Induce vomiting*** immediately by giving 2 glasses of water and sticking finger down throat. Call physician.	Same as Velpar L.	Do not induce vomiting. Rush patient to hospital or physician's office.	Same as Velpar L.	Do not induce vomiting. Call physician immediately.

* When calling physician, consulting physician or taking patient to hospital, have pesticide container available.
** When flushing skin or eyes use plenty of water and continue for at least 15 minutes.
*** Never give anything by mouth to patient who is unconsious and/or having convulsions.
Source: Manufacturers' Labels and Material Safety Data Sheets.

	Vision	Velpar L	Esteron 600 (2,4-D Ester)	Formula 40 2,4-D amine)
FLASH POINT (Closed Cup Method)	>93° C	23° C	171° C	89° C
EXPLOSION OR UNUSUAL FIRE HAZARDS	None.	Flammable liquid.	Noxious fumes (HCl) under fire conditions.	Same as Esteron 600.
EXTINGUISHING MEDIA	Water spray*, foam, dry chemical, CO_2, or any Class B extinguishing agent.	Water spray, foam, CO_2, dry chemical	Water fog, foam, alcohol foam, CO_2, dry chemical	Water fog, foam, CO_2, dry chemical.
SPECIAL FIRE FIGHTING PROCEDURE	Exposure to vapour or products of combustion: - wear self contained breathing apparatus and full protective clothing - equipment should be cleaned after use.	Wear self contained breathing apparatus. Use water spray cool tank/container with spray. If heavily exposed to fire and if conditions permit let fire burn itself out since water may increase contamination hazard.	Positive pressure breathing apparatus.	Same as Esteron 600.

* When using water spray ensure spray does not cause chemical splashing and risk of further contamination.

SYMPTOMS OF EXPOSURE TO 2,4-D, VELPAR L, PRONONE AND VISION

2,4-D

- skin, eyes, nose and throat irritation
- dizziness or giddiness (vertigo), headache
- if ingested: burning of mouth, esophagus, and stomach leading to nausea, vomiting and diarrhea

Velpar L, Pronone (5G or 10G)

- eye, nose, throat and skin irritation
- harmful if ingested

Vision

- eye irritation and conjunctivitis, dermal irritation
- if ingested: gastrointestinal discomfort, nausea, vomiting and diarrhea

EMERGENCY RESPONSE

EMERGENCY PHONE NUMBERS

LOCAL:

Doctor:	
Ambulance:	
Fire Department:	
R.C.M.P:	
Local Poison Control Centre:	
Hospital:	

PROVINCE AND CANADA WIDE:

Canadian Transport Emergency Centre:	(613) 996-6666 - collect
B.C. Ministry of Environment Provincial Emergency Program:	(604) 387-5956
Spills - Dangerous Goods:	Zenith-2667
Workers' Compensation Board:	(604) 273-2266 - days (604) 273-7711 - after 4:30 & weekends
B.C. Poison Information Centre:	(604) 582-5050
Regional Environment Emergency Co-ordinator:	(604) 666-6100
Dow Elanco:	(604) 986-4391
Du Pont:	(304) 774-9898
Monsanto:	(314) 694-4000 - collect